WATER RESOURCES RESEARCH GRANT PROPOSAL

Project ID: 2004DC56B

Title: The Development of a MEMS-based Integrated Wireless Remote Biosensors

Project Type: Research

Focus Categories: Water Quality, Non Point Pollution, Toxic Substances

Keywords: Wireless biosensors, pollutants, ecological quality, drinking water security

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Non-Federal Matching Funds: $30,000

Congressional District: Washington DC

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Abstract

The main theme for this research, education and training proposal is environmental stress assessment for watershed management, ecological quality, and drinking water security. Today, more than ever before, maintaining of our Nations water quality mandates careful and exact assessment that require thorough understanding of contaminant and stressor characteristics, basic ecological processes and principles, transport rates and fate of substances within ecosystems, and health and ecological effects.

Contaminants become a risk to living systems as a result of the dose or concentration they are exposed to and the duration of exposure. Because a large number of factors can contribute to this problem in an ecological system, continuously monitoring for potentially dangerous elements using analytical chemical methods alone is expensive, time consuming, and is not practical. An innovative approach to resolving the periodicity of the analytical sampling problem in a cost effective manner would be to develop a continuously operable, remote, automated biological system; a coordinated monitoring system incorporating both physical/chemical and biological methods that could be

networked into a coordinated surveillance plan for risk assessment and ecological quality control.

This research proposes the design and implementation of an integrated wireless, low-power embedded biosensor monitoring system for the acquisition and transmission of biological functions from aquatic animals. These signals can be used to measure the stress induced in aquatic animals due to water pollution. Over the past decade, research has been active in developing methods pf measuring the levels of stress in aquatic animals for the purpose of monitoring water pollution [1,2,3,4,5,6]. The minimization of power consumption is a critical issue in the design of electronic systems for portable battery-operated applications or remotely powered applications as employed in biomonitoring systems.

In the proposed study a MEMS-based biosensor will be integrated with a mixed-mode ASIC chip comprising of preamplifier, band-pass filter, analog amplifier, D/A module, modulator, transmitter, and a digital controller. The design will integrate MEMS, wireless communication, VLSI, and system-on-chip (BioSilico) technologies in the design of a low power environmental monitoring device. The system will be designed as a battery-powered device. Techniques for analyzing the acquired data will also be developed. The embedded integrated sensors are to be used in the on-line acquisition of myoneural signals from aquatic animals such as bivalve molluscs, blue gill fish, and other fish species. This design is expected to miniaturize several discrete modules and eliminate coaxial cables used in existing biomonitoring setups, and in a significant reduction in the overall system power consumption. A receiver system will be used to receive the signal transmitted from the sensor device. The receiver system will be designed and built using off-the-shelf components. When completed the design will automate the process of in situ environmental data gathering needed to monitor the safety of the drinking water resources. Details of the design will be made available through conference and journal papers.

The proposed research is in collaboration between the Electrical Engineering Department, Biology, and the Environmental Science Department. Students from Electrical Engineering, Biology, and Environmental Science will work in a multidisciplinary research environment to design the biomonitoring system. The project will produce highly qualified graduates with multidisciplinary research experience.